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ABSTRACT

Concerned with historical patterns and with comparisons from one area to another, this report traced the growth of the Navajo and Hopi populations over the past 100 years (1870-1970). Data on fertility, mortality, and migration were obtained from the: Indian Health Service, Bureau of Indian Affairs, U.S. Public Health Service Office of Vital Statistics, and 1950-1970 censuses. Information on migration was based on inferences from birth and death rates. It was found that the Navajo population had increased more rapidly than the Hopi population. It was suggested that epidemic disease among the Hopis until the 1930's accounted for the discrepant rates. Since the 1930's, the Hopi birth rate had declined to figures approaching the national rate, whereas the Navajo rate had declined much more slowly. In addition, it was shown that the age-specific birth rate curves of the two tribes differed significantly, with Hopis terminating their childbearing at an earlier age. It was concluded that the Hopis had experienced accelerated demographic transition over the period of perhaps a generation, so that they had moved from a situation of high birth and death rates to one of low birth and death rates. The Navajos, on the other hand, were experiencing a more prolonged transition, with birth rates remaining high while death rates (especially among infants) dropped rapidly. (Author/NQ)

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demographic change among the hopi and navajo indians

STEPHEN J. KUNITZ

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DEMOGRAPHIC CHANGE AMONG THE HOPI AND NAVAJO INDIANS

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October 1973
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LAKE POWELL RESEARCH PROJECT

The Lake Powell Research Project (formally known as Collaborative Research on Assessment of Man's Activities in the Lake Powell Region) is a consortium of university groups funded by the Division of Advanced Environmental Research and Technology in RANN (Research Applied to National Needs) in the National Science Foundation.

Researchers in the consortium bring a wide range of expertise in natural and social sciences to bear on the general problem of the effects and ramifications of water resource management in the Lake Powell region. The region currently is experiencing converging demands for water and energy resource development, preservation of nationally unique scenic features, expansion of recreation facilities, and economic growth and modernization in previously isolated rural areas.

The Project comprises interdisciplinary studies centered on the following topics: (1) level and distribution of income and wealth generated by resources development; (2) institutional framework for environmental assessment and planning; (3) institutional decision-making and resource allocation; (4) implications for federal Indian policies of accelerated economic development of the Navajo Indian Reservation; (5) impact of development on demographic structure; (6) consumptive water use in the Upper Colorado River Basin; (7) prediction of future significant changes in the Lake Powell ecosystem; (8) recreational carrying capacity and utilization of the Glen Canyon National Recreational Area; (9) impact of energy development around Lake Powell; and (10) consequences of variability in the lake level of Lake Powell.

One of the major missions of RANN projects is to communicate research results directly to user groups of the region, which include government agencies, Native American Tribes, legislative bodies, and interested civic groups. The Lake Powell Research Project Bulletins are intended to make timely research results readily accessible to user groups. The Bulletins supplement technical articles published by Project members in scholarly journals.

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ABSTRACT

The growth of the Navajo and Hopi Indian populations is traced over the 100-year period from the early 1870's to the present. It is shown that the rate of growth of the Navajo population has increased more rapidly than has that of the Hopi population. It is suggested that epidemic disease among the Hopis until the 1930's accounts for the discrepant rates.

Since the 1930's, the Hopi birth rate has declined to figures approaching the national rate, whereas the Navajo rate has declined much more slowly and is still considerably higher than the national figures. In addition, it is shown that the age-specific birth rate curves of the two tribes differ significantly, with Hopis terminating their childbearing at an earlier age than the Navajos.

It is concluded that the Hopis have experienced an accelerated demographic transition over the period of perhaps a generation, so that they have moved from a situation of high birth and death rates to one of low birth and death rates. The Navajos, on the other hand, are experiencing a more prolonged transition, with birth rates remaining high while death rates (especially among infants) drop rapidly.

The reason for these different transition rates appears to be related to the rapidity with which each tribe has been precipitated into the wage economy, and this in turn appears to be related largely to Federal policy as it has influenced the acquisition or loss of land on the two reservations.

In addition, it is shown that there are intra-tribal as well as inter-tribal differences. The western end of the Navajo Reservation appears to be at an earlier phase of the demographic transition than does the eastern end. Age-specific birth rates as well as infant death rates are higher in the west than in the east. As a result of a higher rate of natural increase and more limited job opportunities, the amount of emigration from the western end of the Reservation appears to be greater than that from the eastern end.

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DEMOGRAPHIC CHANGE AMONG THE HOPI AND NAVAJO INDIANS

INTRODUCTION

The Lake Powell Research Project is concerned in part with assessing the impact of the creation of Lake Powell and its attendant developments on the human populations in the area. This impact may be seen as but one example of what some observers have called "modernization," the process by which many of the features of a technologically sophisticated society penetrate the lives of people living until then in relative isolation.

Such a process has been influencing Navajos, Hopis, and other Southwestern Indians continuously over the past several centuries, but the rate of change seems to have increased within the past generation or two, since the 1930's. Different tribes have been influenced at different rates, however, and even within tribes there appear to be regional differences in the intensity of contact with the dominant society. Thus, as will be discussed in more detail in the following pages, the western end of the Navajo Reservation has until recently been relatively more isolated from intense contact with the dominant society than has the eastern end. The building of Glen Canyon Dam, the development of the town of Page, the paving of roads, and the creation of strip mines have all had an important influence on the western end of the Reservation and have served to increase the intensity of contact between Navajos resident in the area and the dominant society. It is not necessary to point out that the relationship has most commonly been an exploitative one with the Reservation assuming many of the characteristics of a colony.

The process of modernization commonly has profound influences on the demographic features of a society: its age and sex structure, fertility and mortality rates, patterns of in- and out-migration, and ultimately family structure, childrearing patterns, and a host of other social-psychological features. Many of these variables are being explored in field studies currently under way as part of the Lake Powell Research Project. The purpose of the present contribution is to sketch the broader demographic picture of the Navajo and Hopi Reservations and the surrounding Anglo-American communities so the field researches in the Lake Powell area may be placed within their regional context. As such, it is concerned both with historical patterns, especially over the past 100 years, and with comparisons from one area to another.

Because this paper will be concerned with comparing rates of relatively rare events and because large numbers are necessary in order to reduce the variance, the units of analysis used are large aggregates such as counties, subagencies, or entire tribal populations. In such an analysis smaller units such as land management districts or chapters are necessarily neglected until a sufficient number of observations are collected through field studies.

Of the three parameters of most concern to demographers--fertility, mortality, and migration--only the first two are treated in detail in this report. Information on migration is based on inferences

from birth and death rates. The dynamics of migration are the subject of field investigations currently under way.

PRE-CONTACT AND PRE-RESERVATION PERIODS

The pre-contact history of the ancestors of the Navajos and Hopis has been discussed by Jennings (1966), Schoenwetter and Dittert (1968), Schroeder (1968), Reed (1954), Jett (1964), Hester (1962), and Underhill (1948). It is worth noting that changing rainfall patterns and other climatic shifts in the eleventh and subsequent centuries forced the ancestors of the Hopis and other Pueblo Indians first to abandon many areas which had until then been suitable for agriculture and then to settle wherever water and arable land were still available. It was into these abandoned areas that the Navajos moved, especially after they had obtained livestock from the Spanish in the sixteenth and seventeenth centuries, with the result that their population seems to have increased fairly steadily (Johnston, 1966; 131f; Hester, 1962). From an estimated population of 4,000 around 1800, they increased to perhaps 10,000 by 1860, though these figures can be regarded only as very inadequate guesses.

During the same period, the Hopi population appears to have either remained constant or declined. Because they, like Navajos, were so far from the administrative centers in New Mexico, census data are very imprecise and irregular, unlike data available from church records for some of the Eastern Pueblos (Aberle et al., 1940). Nonetheless, it does appear that both climatic changes and epidemic diseases introduced by Whites kept the Hopi population from expanding at anything approaching the rate for the Navajos in the 150 years preceding the reservation period (Colton, 1960; 106).

It is generally agreed that throughout the early nineteenth century the Navajos lived to the east of the Hopis. Thus, when in 1868 they returned from 4 years of captivity at the Bosque Redondo, it was to a reservation east of the Hopis. During this period, the Hopis had been allowed to remain in their villages.

EARLY RESERVATION PERIOD

The treaty reservation to which the Navajos returned in 1868 embraced 3,314,330 acres straddling the New Mexico-Arizona boundary (Young, 1961; 255). In 1882 the Executive Order Hopi Reservation was established west of the Navajos and was of about equal size (Kelly 1968; 18-19). Since that time, however, the two reservations have been dealt with differently: the Navajo Reservation had grown to about 14,500,000 acres by the 1930's; the Hopi Reservation had declined to about 631,194 acres at the same time (Thompson and Joseph, 1947; 32).

There are several possible reasons for the expansion of the Navajo Reservation as opposed to the Hopi. First, Navajos as semi-nomadic pastoralists continued to follow their flocks in search of new forage, often spilling over the boundaries of their original reservation. Hopis as sedentary agriculturalists were perceived as not needing as much land to support themselves (despite the fact they

required wood and wild game and in addition did do some sheep-herding). Thus, the federal government did not act to restrain settlement on the Executive Order Reservation and allowed Navajos free access (Committee on Indian Affairs, 1972).

Second, it may be that the Federal Government, concerned about Mormon expansion south from Utah in the last decades of the nineteenth century, used the Navajos as a means of driving a wedge into the chain of Mormon colonies. The Hopis, having allied themselves with the Mormons against the Navajos in the Moenkopi-Tuba City area, may not have been viewed sympathetically by the government.

Whatever the reason, it is clear that the land base of the Navajos was expanded considerably in the period from 1868 to 1934, although it never kept pace with the demand for land. At the same time, and related to the land expansion, the Navajo population increased dramatically. The estimated Navajo population in 1868 was 10,000 to 12,000. By the turn of the present century the population had about doubled, and by 1971 it was estimated at about 130,000 (plus or minus 10 percent).

Johnston (1966; 152) has summarized the pattern of Navajo population growth over the past century as follows:

> "For the period from 1870 to 1900, the average annual rate of natural increase appears to lie somewhere between 1.5 and 2.0 percent; from 1900 to 1930 the rate appears to lie between 1.75 and 2.25 percent; for 1920 to 1950 the rate appears to lie between 2.4 and 2.8 percent; and for the period since 1950 it appears to lie between 2.4 and 3.3 percent."

The Hopi data are equally vague. Tables 1 and 2 give a number of population estimates drawn from a variety of sources. It is clear that, depending on the estimate, the average annual growth rates can vary widely over the same period. What does seem evident, however, is that from 1874 to the early 1900's it increased between 0.5 and 1.4 percent per year. In the 1930's the rate of growth increased more dramatically than the Navajo's to over 2 percent per year. Thompson and Joseph (1947; 30) estimated it to be 2.5 percent at that time. Since the 1940's, though estimates still vary widely, the average annual rate of increase appears to be between 2.0 and 2.5 percent, perhaps at times reaching 3.0 percent. Kennard's (1965) data from Second Mesa indicate a growth rate of 1.96 percent from 1939 to 1961 (including off-reservation residents). The most likely general pattern appears to be an increasingly rapid rate of growth from about 1900 to the late 1950's with a slowing of the growth rate beginning in the 1960's.

Despite the vagaries of the census data, it does seem clear that in the early reservation period, until about the turn of the present century, the Hopi growth rate lagged well behind the Navajo rate. The rate of change increased more rapidly than the Navajo's in the 1930's and remains high, but still appears to be less than the Navajo rate of growth even down to the present time. Hopis themselves have remarked on these discrepant patterns, attributing them to "The Navajo practice of polygyny and Hopi practice of the native religion" (Nagata, 1970; 225). That these

Table 1: Hopi Population Estimates

Year	Population	Source	
1874	1,950	McIntire	(BIA)
1901	1,841	McIntire	(Secretary of the Interior)
1905	2,100	Dozier	(Thompson and Joseph)
1930	2,752	McIntire	(Census)
1934	2,538	McIntire	(BIA)
1940	3,44[illegible]	McIntire	(Joseph)
1950	3,528	McIntire	(BIA)
1960	4,405	Dozier	
1962	5,176	McIntire	(Department of the Interior)
1968	6,000	USPHS	

growth rates are not unique to the Hopi, however, is made clear by examining comparably poor data from the Eastern Pueblos. Table 3 indicates that over the course of the past 100 years population has increased in these Pueblos at lower rates than has the Navajo population, though in general the rate increased rather dramatically after World War II and then began to decline in the 1960's.

It is not immediately evident why the Navajo and Hopi rates should have been so different in the pre-reservation and early reservation periods. A number of possibilities are suggested: (1) more devastating epidemics among the closely settled Hopis; (2) earlier marriage and higher birth rates among the Navajos; and (3) greater off-reservation migration for the Hopis. Each possibility

Table 2: Estimated Average Annual Growth Rates (Hopi)

Inclusive Dates	Average Yearly Change (percent)
1874-1901	-0.23
-1905	0.22
1901-1930	1.38
1905-1934	0.63
1930-1940	2.23
1934-1940	5.00
1940-1950	0.20
	2.39
1950-1962	3.15
	1:31
1962-1968	1.75
1940-1968	2.13

Table 3: Average Annual Population Change: Pueblos (except Hopis)*

Dates	Average Yearly Rate of Change (percent)
1861-1905	0.73
1905-1932	0.86
1932-1942	1.19
1942-1950	1.64
1950-1964	3.71
1964-1968	1.22

* Dozier, 1970; 122.

will be treated briefly, though it should be understood that only tentative suggestions are offered here.

Epidemics

In 1908 Hrdlicka noted that "The living Navaho family is generally moderate in size, but the tribe is increasing in numbers. The living Hopi family is also usually of moderate size...The tribe seems to be slightly increasing in numbers, although it has suffered much from epidemics" (Hrdlicka, 1908; 42f). Severe epidemics of smallpox were noted among the Hopis in the 1850's and 1860's (before the reservation period) and in the 1890's (McIntire, 1970; Bradfield, 1971; Thompson and Joseph, 1947; 29). No mention of a smallpox epidemic of equal severity is found among the Navajos at the same time. Influenza evidently affected both tribes in 1918, but whether or not the death rates differed is unknown.

It appears likely that the Hopi would have been more subject to epidemic diseases simply by virtue of living in more compact settlements (Colton, 1936, 1960). By the same token, endemic diseases such as infectious diarrhea may have been more prevalent also (Rubenstein et al., 1969; Lasersohn, 1965). Titiev noted that in Old Oraibi, "In the 1930's young boys, in particular, did not hesitate to urinate on the terraces before their houses. They were warned only not to wet and thus weaken the walls...As for defecation, members of both sexes used to resort to the outskirts of the pueblo and trusted to cultural blindness to preserve their modesty. These conditions no longer prevail" (Titiev, 1972; 335f).

Natality and Infant Mortality

It is possible that expansion of the Navajo land base led to a stable social structure, increasing wealth, earlier marriages, and a higher birth rate than among the Hopis. As we have pointed out, the Hopi land base was contracting as a result of both the movement of increasing numbers of Navajos onto the Executive Order Reservation and the erosion of much farmland. Indeed, Bradfield (1971) has suggested that the fissioning of Oraibi in 1906 was due directly to the process of erosion which in a very short period destroyed about 800 acres of farmland belonging to members of high status clans.

The author is unaware of any data for the Navajos and Hopis comparable to Hrdlicka's (1931) for the Sioux from the period 1897-1908 or Aberle's (1931) from the Eastern Pueblos that would allow construction of age-specific birth rates for each tribe to see if childbearing began later among the Hopis. From a variety of anthropological accounts it appears that for both tribes sexual exposure began early, that contraceptive techniques were known but not often used, and that therefore childbearing also began early (Bailey, 1950; Whiting, 1939, 35; Simmons, 1942; 145, 282). In addition, all authors tend to agree that breastfeeding in each tribe

lasted until well into the second year of the infant's life, indicating that the period of post-partum infertility and thus child-spacing was likely to have been similar.

Available data concerning birth rates among the Hopis come from estimates provided in the annual reports of the Keams Canyon Hospital for the 1920's and 1930's (BIA, 1920-1935). As Table 4 indicates, the crude birth rate during this period was between 40 and 50 per 1,000, the same as has been estimated for the Navajos (Johnston, 1966; 169) and Eastern Pueblos (Aberle, 1932) at about the same time. Unfortunately, information is not available for the period before 1920, but it seems reasonable that the rates were equally high for the Hopis for at least the first several decades of the early reservation period.

Table 4 also indicates that the infant death rate, even in the better days of the New Deal, was appallingly high, being about 160 per 1,000 live births in 1934. Data provided by Thompson (1950; 61) for 1942 are within the same range: a crude birth rate of 40 per 1,000 and an infant mortality rate of 180 per 1,000 live births. Data from the Navajos in the mid-1940's indicate an infant death rate of about the same magnitude (Johnston, 1966; 173). By comparison, the national figures for 1942 were a crude birth rate of 19.5 per 1,000 and an infant mortality rate of 40 per 1,000 live

Table 4: Keams Canyon Hospital Annual Reports (Hopis)

Year	No. Deaths of Children Under Age 3	Under Age 1	No. Births In-Hospital	Estimated No. of Births
1920	21	ND	ND	103
1921	37	ND	ND	76
1922	38	ND	ND	109
1923	26	ND	ND	90
1924	ND*	ND	ND	ND
1925	36	ND	ND	108
1926	ND	ND	ND	ND
1927	29	ND	ND	108
1928	ND	ND	1	87
1929	18	ND	7	71
1930	18	ND	8	61
1931	ND	ND	9	ND
1932	20	ND	13	83 or 121
1933	32	ND	17	75
1934	35	14	21	123
1935	12	10	37	ND

*No data available.

births. Unfortunately, accurate infant death rates cannot be obtained for either tribe for earlier periods. There is every reason to suspect that they were considerably higher, but it is still unknown whether or how the two tribes may have differed in this respect.

Migration

A third factor to be considered in relation to the discrepant growth rates of the two tribes is migration. As a result of a limited land base, erosion, and increasing dissension within villages, proportionately more Hopis than Navajos may have migrated off-reservation in the early years of the present century. Indeed, the expansion of the Navajo Reservation and the spread of Navajos to new lands might have been the functional equivalent of off-reservation migration in those tribes where the land base either remained constant or was contracted. If off-reservation residents did not return home, they and their children would have stood a good chance of being lost to the tribal rolls, thus allowing the overall picture to show less population growth than did in fact exist.

Unfortunately, there is no information that would allow certain inference of a higher rate of out-migration for the Hopis than the Navajos. Hrdlicka (1908; 6) indicated that in 1903, 350 of 2,210 Hopis (about 15.8 percent) lived off-reservation. Not until the post-World War II period do estimates surpass that figure. Data from 1935 indicated that of 2,634 Hopis, only 102 (i.e., 3.4 percent) were living off-reservation (cited by McIntire, 1970). An estimate by the Bureau of Indian Affairs (BIA) gives essentially the same figure, 4 percent (Thompson and Joseph, 1947; 31). Kennard's (1965) data from Second Mesa in 1939 showed 5.5 percent living off-reservation.

Estimates for the Navajos during the same time period, while probably very inaccurate, were as follows: 1936, 9.9 percent; 1940, 18.9 percent (Johnston, 1966; 124). These data are difficult to interpret due to changing reservation boundaries, residence of many people in the checkerboard area on the eastern end, under-enumeration of less populous areas, and problems related to counting migrant workers as permanent off-reservation residents. Despite these difficulties, however, the figures do seem to show that, at the very least, the rate of migration for Hopis in the first three to four decades of the current century appears to have been no greater than it was for the Navajos and may have been less.

Of the various possible explanations of the discrepant growth rates for the two tribes during the first five or six decades of the reservation period, it would appear that a higher death rate among the Hopis is the most significant. As suggested above, there is no evidence that Hopis had a significantly lower birth rate at this time or that they migrated off-reservation with greater frequency than did the Navajos. In the present study, good indicators of significantly higher death rates among Hopis have not been found, but a variety of sources cited previously all mention

the severity of epidemic diseases among the Hopis, and some remark on their absence among the Navajos.

It has been noted previously that the growth rate of each tribe increased in the 1930's. Speaking of the Hopis specifically, Thompson and Joseph (1947; 31f) suggest that this upturn is due to the Indian New Deal. As a result, health facilities at Keams Canyon Hospital were improved, nurses and other health workers were stationed on various parts of the reservation, protected water sources were developed, hygiene was introduced into the school curriculum, and conservation measures were undertaken. No doubt many of these same features were introduced to the Navajo Reservation as well as to other Indian reservations. The vastness of the Navajo Reservation would have diluted their impact somewhat compared with the influence likely to have been felt on the Hopi Reservation.

Most observers agree that the increase in population was due to a decline in mortality, especially among infants, with a continuing high birth rate (Titiev, 1972; Dennis, 1965; Johnston, 1966), in what has been called the first phase of the demographic transition. In addition to health care, however, wage work became increasingly available during this same period, and there is some indication that Hopis may have taken more advantage of these new opportunities than did Navajos. Government surveys in the late 1930's indicated Hopi per capita income was $163 (Hack, 1942; 16) and Navajo income $78 (Johnston, 1966; 39), though the proportion of total income derived from wages seems to have been about the same (approximately 30 percent) in each case. The higher Hopi income is interpreted to be a reflection of greater involvement in the wage economy, with the Navajos remaining more involved in a subsistence economy.

It is difficult to determine whether differing cultural values between the two tribes account for some of the differences in involvement in the cash economy. It appears likely that some such difference may have been important. What seems clear, however, is that the expansion of the Navajo Reservation and the contraction of the Hopi Reservation would have had the effect of forcing proportionately more Hopis into wage work no matter what their original values may have been. The growth of the Navajo Reservation served to promote pastoralism and allowed Navajos to use wage work as a supplement to more traditional activities (Shepardson and Hammond, 1964, 1970). The same principle does not seem to have held for the Hopis.

It is likely that educational differences between the two tribes was an intervening variable between contraction of the land base and involvement in wage work, but good comparative data are available only for the post-war period. Certainly it is true that simply by virtue of living in densely settled villages the Hopis would have been more accessible to Government truant officers than would Navajos. The differences in involvement with the dominant society seem to be reflected in the population histories of the two tribes in the post-war period.

POST-WORLD WAR II PERIOD

Since the early 1940's, census and vital data concerning American Indians have improved considerably. Information from a number of sources is available. The types of data and their limitations are outlined in the Appendix.

Results from Published Data: To 1968

Davis (1968; 138) has proposed the following thesis: "Faced with a persistent high rate of natural increase resulting from past success in controlling mortality, families tended to use every demographic means possible to maximize their new opportunities and to avoid relative loss of status." It is suggested in this report that the Hopis, having been precipitated more rapidly into the wage economy, were more likely than the Navajos to have reduced their rate of population growth as a means of preserving their new economic gains. Although the data presented are reasonably accurate, it must be emphasized that the intrepretation is at this point speculative and should be regarded as a hypothesis in need of further testing.

One demographic response used to maximize new opportunities is migration. It has been previously stated that an increased rate of Hopi out-migration in the early reservation period could not be documented. There does seem to be evidence for such an increase in the post-war period, however. Nagata (1970; 226) estimates that in the late 1950's and early 1960's about 25 percent of the Hopis and 15 percent of the Navajos lived off their respective reservations. Kennard's (1965) data for Second Mesa indicate 26 percent living off-reservation in 1961. Kunitz et al. (1971) presented similar data gathered in a different manner.

Clearly, better education provides somewhat better access to a wider variety of employment opportunities, and there is evidence also that the Hopis in the post-war period have attained higher levels of education than have the Navajos. Among Hopis aged 25 and above in 1968, the median number of years of education for reservation residents is about 10.5 (BIA, 1969; 44). For Navajos aged 14 and above in 1960, the medians are 5.3 for males and 3.8 for females (Johnston, 1966; 55). Due to inclusion of the 14 to 24 age group, the medians are elevated above what they would have been had the data been available for those Navajos aged 25 and above. Eight years later (i.e., in 1968), this cohort of Navajos would still have been likely to have had a lower median than the Hopis questioned in 1968.

Higher economic status and educational levels also have been related to another important demographic response to new opportunities: that is, limitation of family size. In general, birth rates among Canadian Indians (Romaniuk and Piche, 1972), American Indians, and Alaska Natives (USPHS, 1971) have followed a curve similar to that of the rest of the population in North America. Though birth rates are still much higher than in the general population, they have been declining considerably. Fertility of Canadian Indians has declined from 46.1 per 1,000 in 1960 to 36.8 per 1,000 in 1969. For American Indians and Alaska Natives the decline has been somewhat less dramatic: from 42.5 per 1,000 in 1960 to 38.5 per 1,000 in 1968. The differences among areas are of somewhat greater magnitude, however.

For example, fertility in the Albuquerque Area, which includes Southern Utes and Jicarilla and Mescalero Apaches as well as the Eastern Pueblos, went from 39.1 per 1,000 to 34.8 while the Navajo Area (which includes the Hopis) went from 46.6 to 39.7 over the same period. Although these rates are still about twice the national figures (23.3 to 17.5), they seem to indicate the beginning of a

downward trend which may have considerable significance in years to come.

At the same time, of course, the population is continuing to grow at a rapid rate due to the decline in infant mortality. In 1955 the infant death rate (per 1,000 live births) in the Navajo Area was 87.8; in 1967 it was 38.7. The corresponding figures for the Albuquerque Area were 86.8 and 37.1. Comparable figures in the general population were 26.4 and 22.4.

For purposes of this study, however, these figures can only give indications of gross changes. Because the Navajo Area data group Navajos and Hopis, and because the former tribe is so much larger than the latter, the figures are representative of the Navajos and do not show any inter-tribal distinctions. In addition, these data do not demonstrate any areal differences on either the Navajo or Hopi Reservations.

That such areal distinctions do exist, on the Navajo Reservation at least, is clear from data published previously. Johnston (1966; 130) has shown that the population at the eastern end of the Navajo Reservation has grown much more rapidly in the 22 years between 1935 and 1957 then it has elsewhere. This is probably due to migration to sources of wage work which are more plentiful in the east than elsewhere on the Reservation. Chinle, for example, which had a crude birth rate of 48.4 per 1,000 in 1957 (McDermott et al., 1972), grew by only 33 percent during the period 1935-1957. This pattern of intra-reservation migration would be likely to have the effect of attracting young, relatively more acculturated people to sources of wage work. Indeed, Hillary and Essene (1963) found in their analysis of the 1960 U.S. Census that the census county division which includes Fort Defiance and Window Rock, the headquarters of the Tribe as well as various federal agencies, had a fertility ratio of 803, which is lower than that of any other part of the Reservation.

Unfortunately, the census county division that includes the Hopi Reservation also includes large areas of the Navajo as well so that it is impossible to make any inter-tribal comparisons. However, using data from BIA's 1968 census of the Hopi Reservation, some rough comparisons can be made. The fertility ratio of the Hopi Reservation in 1968 was about 600, which is within the range of many Anglo communities in the surrounding states. Fertility ratios for a number of other locations follow: Keams Canyon, which is a headquarters for both the BIA and the Indian Health Service, 577; New Oraibi which is the Tribal headquarters, 641; the three Third Mesa villages, 504; the three Second Mesa villages, 748; Polacca, 457; the three First Mesa villages, 687; and Moenkopi, 555. Given the rather small numbers in each village, even clustering them by mesa, it is probably not appropriate to read too much into these differences. What is important, however, is to note the fact that all areas are lower than the lowest Navajo area. Thus, though it was not possible, using the Public Health Service data on birth rates by Area, to distinguish between the Navajos and Hopis, it appears

from these data, crude though they are, that there are in fact differences in fertility between the two tribes.

It should be emphasized, however, that these data apply only to the reservation populations. As yet there are no comparable data available for off-reservation residents. What data do exist come from an attempt to enumerate completely all Hopi residents of three Arizona border towns (Holbrook, Winslow, and Flagstaff) in the summer of 1971. The total number of individuals located was 761, which is probably 95 percent of the Hopis living in those towns and about one-half or one-third of the total number estimated to be living off-reservation.

Of these 761 individuals, 128 were 5 years of age or younger and 159 were women between 15 and 44. Thus the fertility ratio of this group was 805, somewhat higher than the ratio found on the Hopi Reservation in the BIA's 1968 census. These results contrast with the pattern described among Papago urban migrants where the women tend to be unmarried and involved in domestic work (Uhlmann, 1972), and it seems clear from these data that the fertility experience of off-reservation families is considerably different than that of reservation families.

Using the fertility ratio, it is possible to calculate the approximate crude birth rate for the 5 years preceding the census (Johnston, 1966; 155, note 6). Using this method with Hopi Reservation data and assuming an infant mortality rate of 40 per 1,000 live births, the average yearly crude birth rate over the 5 years ending in 1968 is calculated to be about 25 per 1,000. (In contrast, the group interviewed off-reservation had a rate of between 30 and 35 per 1,000). Even allowing for selective migration of women with many children, the rate is considerably lower than that of the Navajos and in fact is only slightly higher than the national figures for the same period. Even assuming considerable error, the rate does not appear likely to have been above 30 per 1,000, which is still low compared to the Navajos.

Results from Unpublished Data: 1970 to 1971

We have so far been able to show that the Hopis have experienced a rapid demographic transition since the 1930's, analogous to the experience of the Japanese, whereas the Navajos have experienced a more delayed transition characteristic of most developing nations (Omran, 1971). By this it is meant that within the space of a generation the Hopis have moved from a situation in which they had both high birth and death rates to one in which both rates were lowered very dramatically. The result has been that the Hopis never seem to have experienced a rapid rate of population growth over a prolonged period of time. The Navajos, on the other hand, have experienced a dramatic drop in death rate while the birth rate has declined only very slowly. The result has been a

continuing rapid increase in population, a situation which is characteristic of most developing nations.

In this section data are presented from the Indian Health Service (IHS) in-patient and contract tapes which confirm the different birth rates reported for the Hopis and Navajos and which allow construction of age-specific birth rate curves for each tribe.

The shapes of age-specific birth rate curves have been categorized into three types (United Nations, 1965; De-Jong, 1972): (1) the broad peak type said to be characteristic of developing nations in which birth rates in the 20 to 24 and 25 to 29 age groups differ very little, are higher than the rates in groups above and below those ages, and decline in the older age groups as a result of menopause; (2) the early peak type, with births reaching their highest point in the 20 to 24 age group, and (3) the late peak type, with births reaching their highest point in the 25 to 29 age group. Types 2 and 3 are said to be characteristic of developed nations. Although virtually all societies have peaks in the twenties age group, the point emphasized here is that so-called developing nations have a broader pattern than do developed nations. Figure 1 illustrates all three types: Colombia represents 1; the United States 2; and Japan 3 (calculated from data in Keyfitz and Fleiger, 1968).

Since the Hopis appear to resemble the Japanese in the rapidity with which they have undergone the demographic transition, there would be some reason to expect that the age-specific birth rate curves would have been similar in the two societies. Figure 2 shows the curves for both Navajos and Hopis, and it is clear that Hopis follow the early peak type of pattern, and that Navajos are not readily categorized, appearing to be transitional between the broad peak of type 1 and the early peak of type 2. These data suggest that although the Navajos have a high growth rate, there is some reason to believe that the rate is likely to begin declining if births to older women continue to decrease as they seem to have within recent years.

Because the number of Hopi births is so small, age-specific rates are likely to be unstable. The analysis is therefore presented in a somewhat different form in Table 5. Using several different estimates of Navajo population and the number of Navajo births, and applying them to the Hopi population, expected frequencies of Hopi births have been computed and the chi-square values have been calculated to test the hypothesis that the age distribution of births does not differ between the two tribes. In each case the differences are

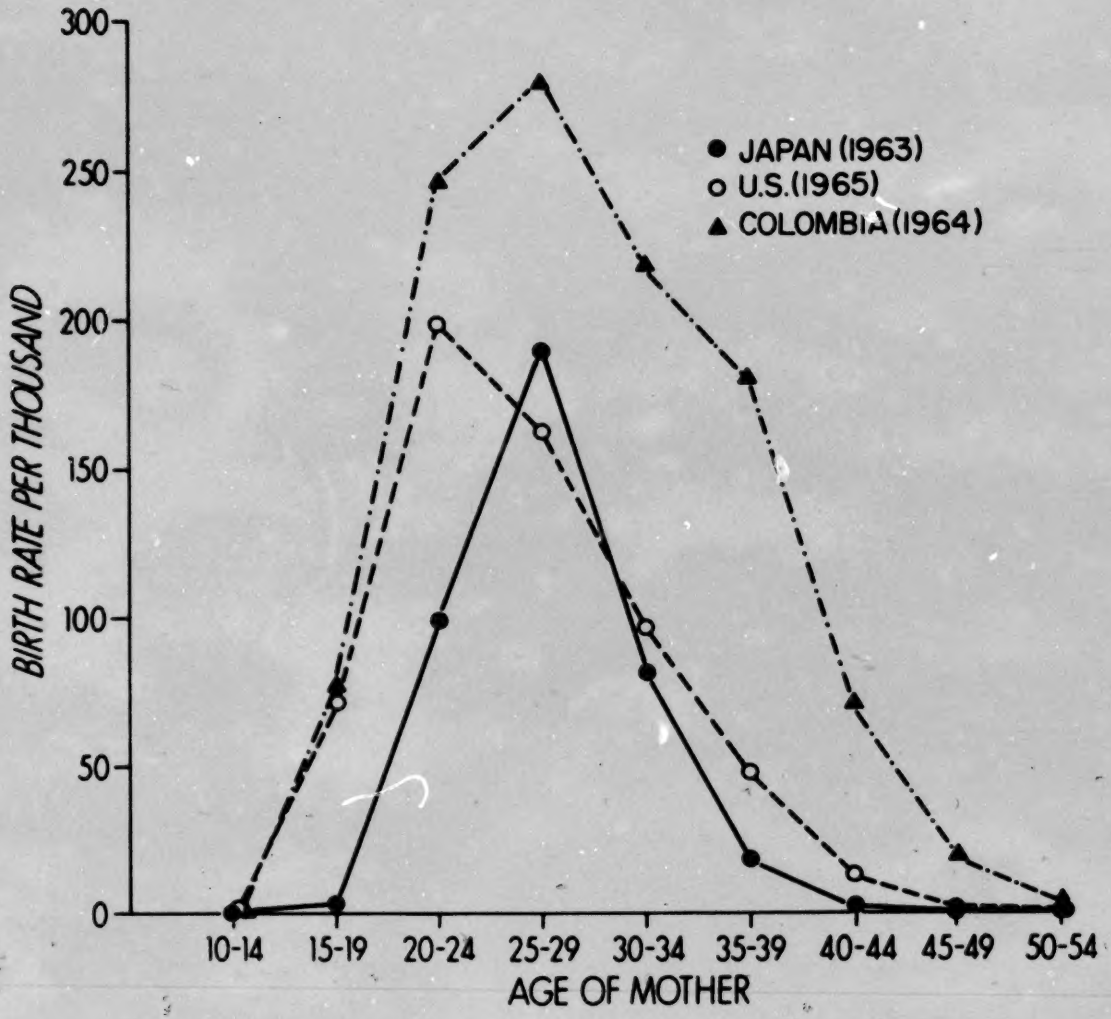

Figure 1: Age-Specific Birth Rates in Selected Nations

significant, and it is clear that Hopi women do bear a greater proportion of their children at younger ages than do Navajo women. That this pattern is not a result of Navajo women deferring childbearing until their late twenties or thirties is demonstrated by a review of IHS outpatient tapes which reveal that about 50 percent of the primigravidas in each tribe are between 20 and 24.

The patterns within tribes are not constant from place to place, however. As Figure 3 indicates, the Tuba City subagency has generally higher age-specific birth rates than the other areas. A chi-square analysis was performed by fitting an additive model in the logit scale. The chi-square goodness-of-fit test on 28 degrees of freedom was 72.5, which is significant at less than 0.001 (C. L. Odoroff,

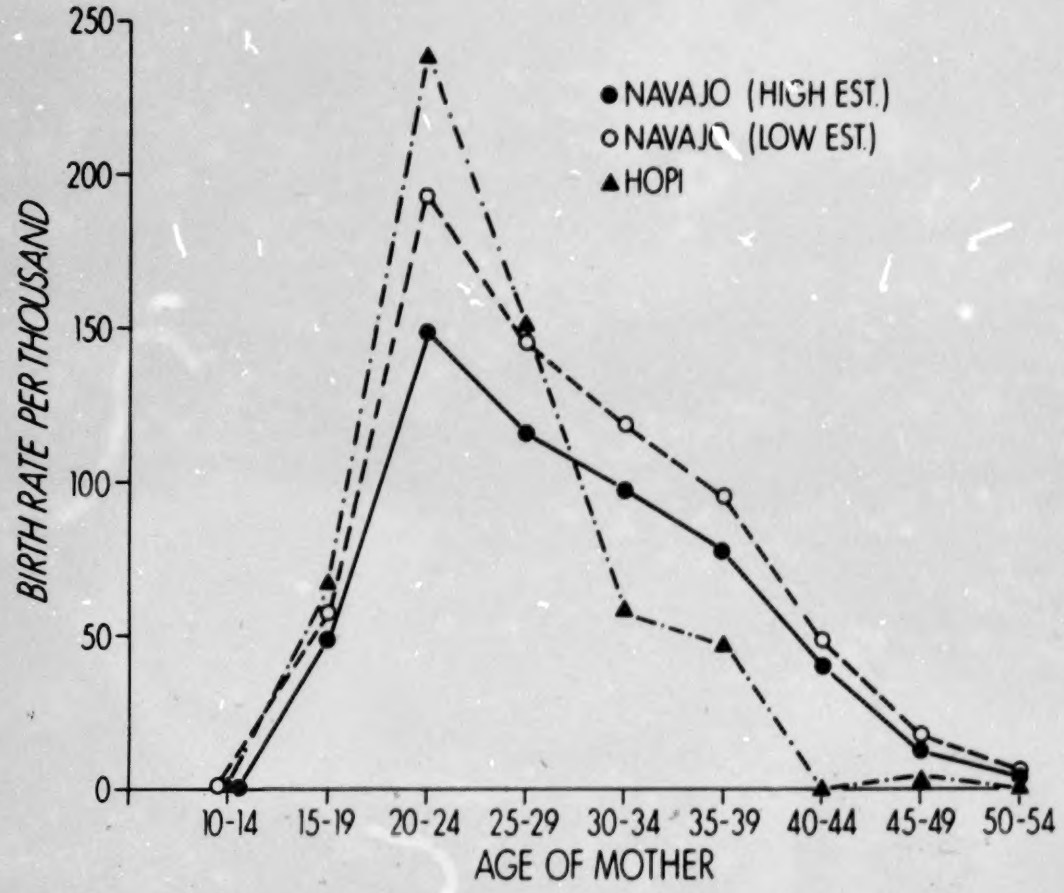

Figure 2: Hopi and Navajo Reservation Age-Specific Birth Rates, 1971-1972 Average

personal communication). This is a reflection of inconsistent differences between age groups of women in different subagencies. It is striking, for example, that the rate for women aged 40 to 44 in Tuba City drops below the rate for women in Chinle. (Figure 4 shows the location of the different subagencies and counties.)

The western end of the Navajo Reservation has been less intimately in contact with the dominant society, is less industrial, and has fewer centers of wage work than are found elsewhere (Harman et al., 1969). In addition, as the figures in Table 6 indicate, the infant mortality rate on the western end is higher than it is elsewhere. Thus, it would appear that the higher birth rate in the Tuba City subagency is related in large part to a higher infant death rate on the western end of the Reservation.

The effect of a lowered infant mortality rate is similar in direction though not in magnitude to an elevated birth rate. It thus appears that the

Table 5: Expected Hopi Reservation Births
(average for 1971 to 1972)

Age Group	No. Observed Hopi Births	No. Expected Hopi Births A	B	C	D
10-19	20	15.6	19.1	17.8	21.8
20-24	48	29.1	37.6	33.0	42.7
25-29	22	17.0	20.8	19.0	23.6
30-34	9	13.8	16.9	15.7	19.2
35-39	6	9.7	11.9	10.9	13.3
40-54	1	7.2	8.9	8.1	10.0
Chi-square		23.38	16.60	18.82	18.40
d-f		5	5	5	5
p-value		0.001	0.01	0.01	0.01

A = based on high Navajo population estimate; B = based on low Navajo population estimate; C = based on high estimate plus 400 additional births; D = based on low estimate plus 400 additional births.

lower birth rate on the eastern end of the Navajo Reservation is offset to some slight degree by the lower infant death rates. The net effect reservation-wide would then seem to be intrinsic rates of natural increase that are more nearly similar than the age-specific birth rates alone would have suggested.

Though the data include information on some Navajo women who give off-reservation addresses, such information has not been utilized because so little is known of the off-reservation population concerning numbers, length of stay, and area of origin. In addition, it is known that there are Navajo communities of significant size in cities outside the area covered by the records, such as Denver, Dallas, Los Angeles, and Chicago. It is possible to say that, counting the deliveries recorded within the service area of "Navajo country," which would include off-reservation border towns and nearby cities as well as the reservation itself, and estimating about 400 births per year lost to the record system, the crude birth rate appears to be between 28 and 34 per 1,000. That is, there are approximately 4,000 births per year in this population and the rate depends on the denominator used. It should be pointed out, however, that even 34 per 1,000 represents a decline from estimates of rates of several years ago.

The problems of dealing with differences within the Hopi population are equally formidable. Information on differences between villages has not been provided in this report because the numbers are small enough and the time period covered so short that the rates discovered are likely to be very unstable. For such an analysis, a longer time period would be desirable and that will be the subject of

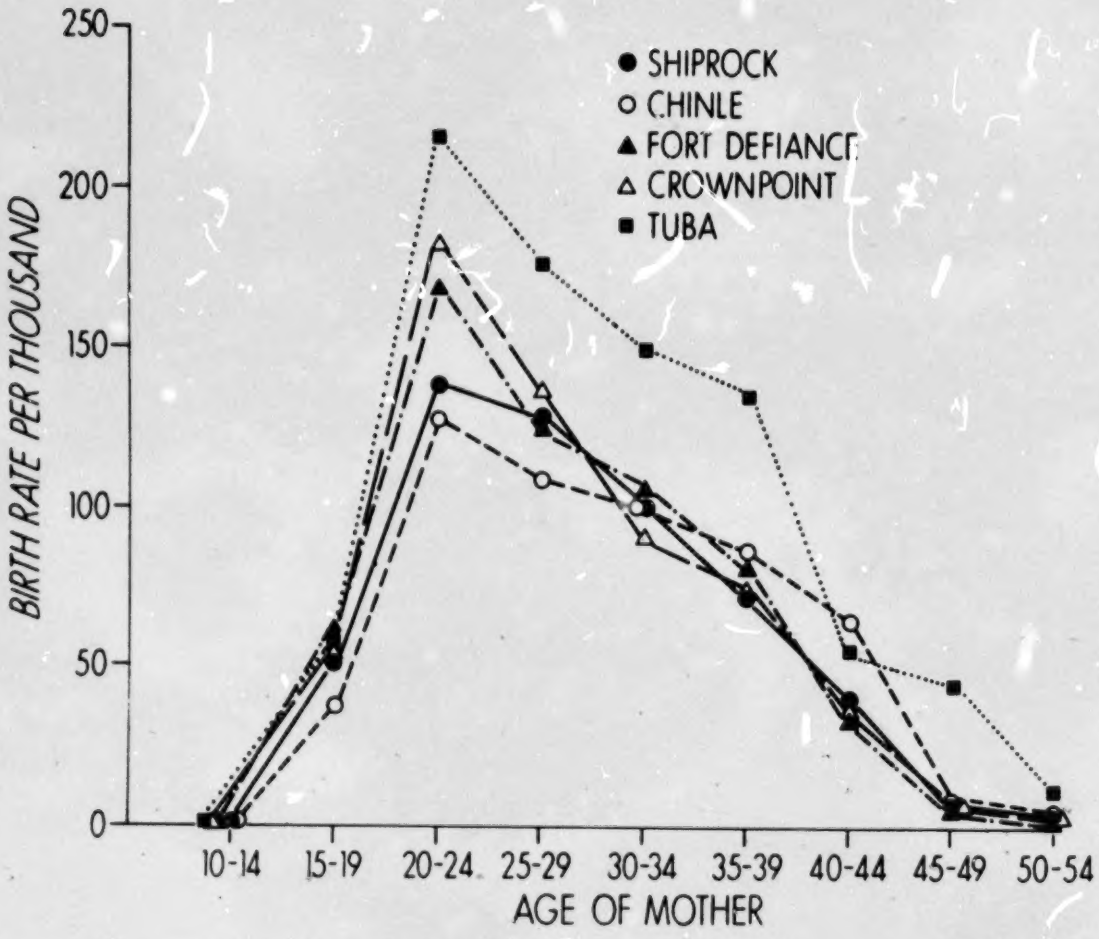

Figure 3: Navajo Age-Specific Birth Rates by Subagency, Fiscal Year 1971-1972 Averaged

future investigations. The average number of on-reservation births for each of the 2 years of this study was 106. With a population of between 5,000 and 5,500, the crude birth rate is in the range of 19.3 to 21.2 per 1,000.

It has been observed that the off-reservation Hopi population appears to have a higher birth rate than the on-reservation population. This rate was calculated from a 1971 census of all the Hopi residents of the border towns of Holbrook, Winslow, and Flagstaff, Arizona. The data from the IHS yield an average of 55 births per year to off-reservation Hopi women. If it is assumed that between 25 and 33 percent of the Hopis live off-reservation, then between 1,600 and 2,500 Hopis live off their reservation and the crude birth rate is between 22 and 34 per 1,000.

Moreover, if it is assumed that (a) the age distribution of the women enumerated in the 1971 survey of border towns is representative of the age distribution of

Table 5: Average Annual Indian Infant Death Rates Per Thousand Live Births

Years	County				
	Apache	Coconino	Navajo	McKinley	San Juan
1950-1954	100.0	134.6	136.0	120.0	141.0
1955-1959	62.0	79.2	79.7	74.0	71.0
1960-1964	48.5	62.0	60.0	49.0	41.0
1965-1968	40.5	58.7	52.0	35.3	50.0

all Hopi women living off-reservation, and (b) the total of off-reservation residents is three times the number of border town residents (i.e., total off is 2,283, possibly an over-estimate), then an age-specific birth rate pattern is obtained as shown in Figure 5. Comparing it to the reservation pattern displayed in the same figure, it is noted that the difference in crude birth rates seems to be accounted for by continuing births to off-reservation Hopi women in their early thirties.

It has not been possible to account for the higher birth rate off-reservation. A lower rate would have been expected. The higher rate may be due to under-estimation of the number of off-reservation residents or to migration of a more fertile population. This remains a topic to be investigated further in the future, although based on our census of border town residents, it appears that the higher birth rate is a real finding and one that needs to be explained.

Finally, with an average of about 160 births per year in a total population of 6,500 to 7,500 on- and off-reservation, the Hopi crude birth rate is between 21.3 and 24.6 per 1,000, still lower than the lowest limits calculated for the Navajos.

County Data

The preceding sections have utilized data provided primarily by the IHS and BIA in published and unpublished form. This section draws on county data provided by the U.S. Census and the USPHS Office of Vital Statistics. The limitations of these data have been emphasized in the Appendix: under-enumeration of Indians, under-registration of births and deaths, and failure to distinguish between members of different tribes and residents on- and off-reservation. Nonetheless, the data are valuable because they allow us to compare each county in 1960 and 1970 and, by correcting for rates of natural increase, to estimate the net levels of migration for Whites and non-Whites (more than 95 percent of whom are Indians) (Barclay, 1958). Figure 4 shows the overlap between counties and sub-agencies on the Hopi and Navajo Reservations; Table 7 shows the populations of each county in 1960 and 1970; and Table 8 shows the vital rates and migration pattern in the five counties.

There are a number of striking features revealed in Table 8: for both Whites and non-Whites, the crude birth rate is dropping, though at different rates in different counties; crude death rates

Figure 4: Location of Subagencies and Counties

have tended to change very little over the 1960-1970 decade; and migration patterns differ radically from one county and racial group to another.

In every county but San Juan, the non-White crude birth rate, though declining, remains considerably higher than the White rate. In San Juan County, the non-White rate was lower in 1968 than the White rate. More generally, it appears to be the case that the three Arizona counties had a larger net loss of Indians due to migration (between 19 and 28 percent) than did the New Mexico counties. Indeed, San Juan County had a net loss of only 4 percent of its Indian residents. Conversely, the three Arizona counties lost a smaller proportion of their White populations, Navajo County even gaining 6 percent due to in-migration.

SUMMARY AND DISCUSSION

The results of this study suggest that the Hopis and the Navajos present

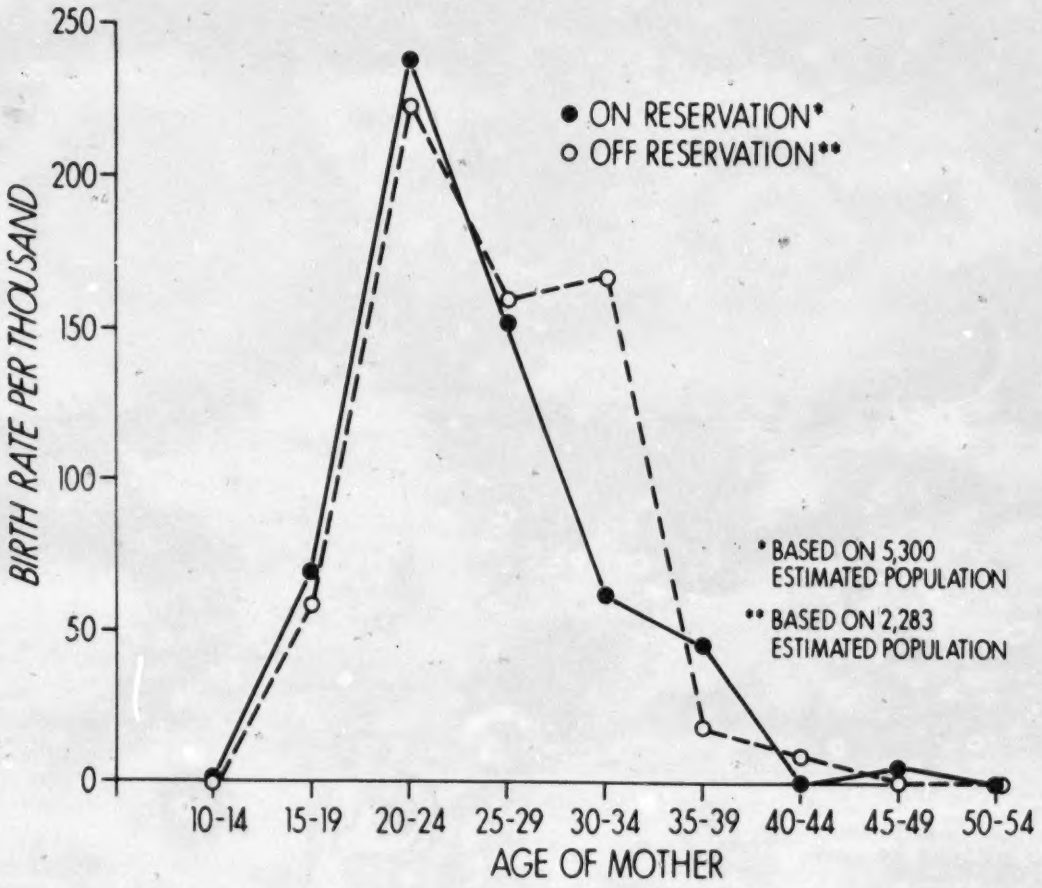

Figure 5: Estimated Hopi Age-Specific Birth Rates On- and Off-Reservation, 1971-1972 Averaged

two very different patterns of demographic transition. The Hopis appear to have made a very rapid transition from a situation in which they had both high birth and death rates to one in which they have lowered both rates dramatically. In addition, the period of childbearing is concentrated in the early twenties age group.

The cause of this accelerated transition appears to lie in the contraction of the Hopi land base and their resulting increased involvement in the dominant society both through educational institutions and wage work. In this they contrast markedly with the Navajos, who manifest a delayed type of transition which is more characteristic of most developing nations (Omran, 1971).

It is suggested in this report that the delayed pattern is the result of the expansion of the Navajo land base and the persistence of many features of traditional pastoral life. Indeed, it appears that wage work for many Navajos has continued to be primarily a supplement to the

Table 7: Population of San Juan and McKinley Counties, New Mexico, and Navajo, Apache, and Coconino Counties, Arizona

County	Total Population	Percentage Indian	Non-Indians with Spanish Surnames: Percentage of Total	Non-Indians with Spanish Surnames: Percentage of Non-Indians
San Juan				
1960	53,306	26.7	6.8	9.3
1970	52,517	35.1	---	
McKinley				
1960	37,209	56.7	12.2	28.0
1970	43,208	61.4	---	
Navajo				
1960	37,994	50.9	6.9	14.0
1970	47,715	48.3	---	
Apache				
1960	30,438	74.8	3.2	12.5
1970	32,298	74.3	---	
Coconino				
1960	41,857	27.9	10.4	14.4
1970	48,326	24.8	---	

more traditional subsistence economy. However, such changes are not occurring at the same rate throughout the Navajo Reservation.

Fertility

It is typical of the delayed demographic transition that birth rates remain high until well after death rates have declined, thus leading to an explosive growth in population until the birth rate declines and equilibrium is restored. The Navajos have manifested this pattern over the past several generations. From a crude birth rate somewhere between 40 and 50 per 1,000, the rate has now dropped to about 34 per 1,000. There are, however, regional differences. Apache, Coconino, and McKinley Counties all have birth rates of nearly 40 per 1,000 or above. Navajo County has a rate of 34 per 1,000, which may be accounted for in part by the fact that about 20 percent of the Indians living there are Hopis. San Juan County has a birth rate in the mid-twenties.

In addition, the age-specific birth rate curves indicate that the western end of the Navajo Reservation has a pattern much more similar to what is found in a developing nation such as Colombia than do other parts of the Reservation. That this is not due to many women delaying childbearing until their thirties is indicated by a review of prenatal clinic records which showed that approximately half of all Navajo and Hopi primigravidas in 1970 and 1971 were in the 20- to 24-year-old age group.

These differences would seem to indicate that the western end of the reservation is still considerably less influenced by the social and economic institutions of the dominant society than is the eastern

Table 8: Vital Rates and Migration in Five Southwestern Counties

County	Crude Birth Rates 1950*	1960	1968	Crude Death Rates 1950	1960	1968	1960-1968 Migration** (Number)	(Percent)
San Juan								
Indian	31.5	40.0	26.7	15.9	6.9	5.8	- 802	- 4.0
White	32.5	34.1	28.6	7.5	5.2	5.5	-12,429	-27.0
McKinley								
Indian	32.4	45.6	39.3	12.0	8.4	7.3	- 3,614	-11.8
White	33.6	31.2	19.5	8.3	7.5	7.4	- 2,286	-12.5
Apache								
Indian	30.0	51.0	49.0	11.1	8.8	8.5	- 9,784	-28.6
White	27.0	34.0	26.5	5.2	9.5	5.1	- 655	- 7.8
Navajo								
Indian	33.4	43.1	34.0	12.5	8.2	6.4	- 5,283	-19.3
White	28.9	32.2	22.4	7.6	5.7	6.3	+ 1,307	+ 5.9
Coconino								
Indian	42.5	41.0	44.0	11.1	6.9	6.8	- 4,506	-25.0
White	27.8	31.4	20.3	4.9	6.4	5.4	- 1,036	- 2.9

* Under-registration of births for Indians in 1950 probably makes these figures of doubtful value for the most part.

** - signifies loss of population; + signifies gain of population.

end of the reservation. It would also suggest that family planning programs may have most success with older, multiparous women among the Navajos and with younger women among the Hopis. Only after the age-specific birth rates in the older age groups decline is it likely that younger women with fewer children will become receptive to family planning.

The implications of different levels of fertility for family structure are also important. First, it is obvious that if women continue bearing children into their late thirties and early forties, most marriages will not be without some children to raise until the marital partners are in their late forties or early fifties. Contrast this to the emergent Hopi pattern where most women will be in their early forties when the last child is capable of being self-supporting. Clearly, there is bound to be a significant change in marriage roles as a result. This same pattern may be developing among Navajos in the San Juan County area though the data are not precise enough to document that as yet.

Second, it is also clear that the more children born and surviving to adulthood, the more likely is there to be competition within the family unit and among families for scarce resources. As a result, patterns of cooperation will likely continue to change and increasingly be confined to the residence unit, or even the nuclear family, rather than extending to include several different residence units.

Third, changing fertility patterns have an important influence on the age structure of a population. A population

with high fertility is a young population whereas the reverse is true of a population of low fertility. Thus, within another generation, the Hopi population ought to have a significantly larger proportion of elderly members. This is not likely to be the case with most segments of the Navajo population except perhaps those people living in the San Juan County area. Such a changing age structure will influence both the disease patterns found in the two tribes (with the Hopis likely to manifest a higher proportion of chronic and degenerative diseases) and the problem of dependency. As the Hopi population ages and as many young people move away, the residual reservation population is likely to find itself without the day-to-day supports that are characteristic of societies organized around the extended family. It is in this setting that a variety of government social service agencies may assume increasing importance. Unlike the Navajo population, where dependency tends to be found in the younger age groups, those agencies serving the Hopi may well find that they are being faced with a somewhat different set of problems in an older population.

Mortality

Table 6 shows the average annual Indian infant death rates for the five counties from 1950 to the end of the 1960's. It is clear that the rate has dropped dramatically in each county. There is also some evidence that it has not changed dramatically in Coconino County since the late 1950's, unlike the rates in the other four. It is possible that this deviant pattern is the result of poorer living conditions which, beyond a certain level, cannot be compensated for by good acute medical care as is now provided by IHS. As partial confirmation, Table 9 shows the proportions of Indian children under one year of age who die within the first 28 days of life. It is noted that in each county but Coconino the proportion tends to increase from 1950-54 through 1965-68. The significance of this change is that those deaths occurring within the first 28 days are likely to be due to some type of congenital anomaly or birth defect rather than to environmental conditions. White infants in these same counties die almost entirely within the first 28 days, for example. Thus, there is some indication that in Coconino County the environmental conditions are more hazardous to the health of Indian infants than are the conditions in other counties.

It would appear that there is some association between high birth rates and high infant death rates, but what the nature of the relationship is it is impossible to say. It must be remembered that these are aggregate data, and therefore it cannot be inferred that it is the very same women who lose children in infancy who are also responsible for the high birth rate. Thus, while it would seem logical that families have some notion of desired family size and that they keep having children until they have reached that size despite many deaths, the data presently in hand only illustrate the association between high birth and death rates in the region of the western end. It is equally conceivable, of course, that the association goes the other way: the more children, the less able is a family to care for them and therefore the higher the death rate.

It should also be noted that the crude death rates (all deaths per 1,000 population) have not changed significantly over the past decade (see Table 8). This is not surprising and is

Table 9: Proportion of Indian Infant Deaths Occurring Within the First 28 Days of Life

Years	County				
	San Juan	McKinley	Apache	Navajo	Coconino
1950-1954	24.0	31.0	24.0	24.0	26.0
1955-1959	31.0	33.7	35.0	27.0	40.0
1960-1964	34.0	39.0	33.7	30.0	25.0
1965-1968	40.0	42.0	33.5	43.0	28.0

similar to patterns found elsewhere. It serves to emphasize, however, that in the later phases of the demographic transition, intrinsic rates of natural increase are more likely to be influenced by changes in fertility than by changes in death rates. Indeed, the variations in the rates of natural increase in the five counties are attributable almost entirely to variable declines in the birth rates.

Migration

We have shown that the three Arizona counties which include part of the Navajo and all of the Hopi Reservations have a much larger net loss of non-Whites than Whites: McKinley County, New Mexico, has about an equivalent loss of both groups; and San Juan County has a pattern of loss that is essentially the reverse of that found in the Arizona counties (see Table 7). It would be a mistake, however, to assume that those individuals remaining in each county represent a residual population. Though in many instances this may be the case, it is also true that there is a rapid turnover of individuals within counties. This has been documented for the populations of Flagstaff (Coconino County) and Winslow (Navajo County) where, respectively, 29.6 and 21.4 percent of the families had resided in each place less than 3 years when surveyed in 1969 (ASES, 1969, 1970).

Though comparable data regarding the reservation populations are not available, it does seem likely that the figures of "net loss" or "net gain" mask a great deal of shifting about of the populations remaining in each area. It is entirely possible, for example, that the development of wage work opportunities on Black Mesa and in the vicinity of Page has not attracted primarily local residents from the neighborhood but has attracted back to the reservation individuals who had been living elsewhere, perhaps in large cities such as Los Angeles, Denver, and Dallas. Thus, the loss of Indian residents of Coconino County may have been 6,500 over the decade of the 1960's, with a replacement of 2,000 by people native to other counties. Without data from field studies it is not possible to determine anything more than the net figures.

It is clearly important to understand the migration process in more detail than these data can provide. If a significant proportion of the population in some areas is being replaced by individuals returning from large cities, then there are likely to be important

ramifications on the reservation. For example, people who have spent some years living in cities may be of a more liberal political persuasion than those who have remained on-reservation. From previous work, there is some evidence that this is the case (Kunitz and Levy, 1970). In addition, returnees may well have acquired new values relating to family organization, consumption patterns, childrearing practices, and the like, and they will likely influence many people who have not migrated.

Finally, it is evident that large numbers of Navajos have been forced to leave the reservation. Should wage work opportunities become available that would attract them back, the reservation would continue to be faced with the problems of population growth and competition for scarce resources that plague it now, even were the rate of natural increase to decline significantly (T. Boyle, personal communication). Generally, however, the population is growing more rapidly than is the number of jobs, and it is likely that migration will continue to be an important feature of reservation life in the foreseeable future. (For a somewhat similar analysis of Papago migration, see Hackenberg and Wilson, 1972).

Though the data are far from ideal, the general picture that has emerged is of two tribal populations which have made markedly different adaptations to the process of modernization because of the different impact it has had on each of them. The Hopis, having lost land and living in more compact settlements, appear to have made an accelerated demographic transition to a pattern of low fertility which resembles that of the dominant Anglo-American society. This report suggests what some of the results of such a transition might be, but clearly there will be others such as the influence on inheritance patterns, ceremonial life, and even, perhaps, mythology (Kunitz and Levy, MS).

The Navajo population has gained considerable land over the past 100 years, and this appears to have led to the persistence of a subsistence economy supported by outside agencies. Because many Navajos have been able to continue to live in remote and isolated areas, they have been somewhat removed from the immediate influence of the dominant society. The western end of the Reservation has until very recently been particularly isolated, and the result has been that different demographic patterns are manifested there than on the eastern end. Generally, the western end shows higher infant mortality rates, higher crude and age-specific birth rates, and higher net loss of population due to migration. All this suggests that the western end is at an earlier phase of the demographic transition and that the resulting rapid rate of natural increase in the face of lower levels of economic development is forcing the emigration of larger numbers of people.

It is in this context that the creation of Lake Powell and its attendant economic developments may have some impact on the population structure of the western end. What that impact is likely to be will be determined in large measure by the benefits accruing to the Navajos as opposed to some other group. If Navajos have no significant permanent share of the jobs created in the area, then the demographic picture will probably continue as it is for quite some time to come.

APPENDIX

METHODS

When calculating rates, one needs a numerator and a denominator. The numerator consists of those events being measured--births and deaths, for example--and the denominator consists of the population in which those events occur.

Numerator data in this study come from two sources. Data used in constructing age-specific birth rate curves come from the IHS of the USPHS and are IBM taped records of all discharges from IHS facilities for fiscal years 1971 and 1972. In addition, comparable tapes are available from those facilities with which the IHS has contracts to treat Indian patients. This study used tapes from the Phoenix and Navajo Area Offices, so the vast majority of facilities providing services to Navajos and Hopis were covered.

There are clear limitations to these data. First, an unknown number of Hopi and Navajo women deliver elsewhere: either in other hospitals where their expenses are paid by themselves or by a third party other than the Government, or at home. In such cases, these deliveries would escape the recordkeeping system used for this report. Second, tribal affiliation and other characteristics may be recorded inaccurately. Third, during fiscal year 1971 a considerable number of records from the Navajo Area were lost before they could be punched on tape.

With regard to the first problem, an effort has been made to interview medical record librarians at all hospitals on and around the two reservations in an attempt to gain some understanding of the loss to the system that deliveries in other than IHS or contract hospitals would represent. At the Monument Valley Hospital (Seventh Day Adventist) a 20-percent random sample of all discharges during fiscal years 1971 and 1972 was coded and counted in the tabulations of this report. At other hospitals serving fewer Hopis and Navajos an attempt was made to estimate the number that would have been lost because of different mechanisms of payment than contract with the IHS. On the basis of these interviews, it is estimated that records are lost of 300 to 400 Navajo deliveries per year and of perhaps 10 Hopi deliveries. We cannot tell how many children were not born in a hospital. The IHS estimates that 95 percent of all Indian children are now born in hospitals, but this figure obviously can vary from one tribe or region to another. It has been necessary to assume, however, that for the two tribes discussed here the same proportion is delivered in hospitals and that the loss which does occur is random.

As to adequacy of recording characteristics of mothers, it is necessary to assume that the vast majority of records are valid. A sample of IHS records has been recoded and matched with the tapes

provided by the IHS. The matches are upwards of 90 percent on virtually all parameters, permitting some confidence in the reliability of the records. However, the validity (how well the records reflect reality) is something which is necessarily assumed.

For the third problem, loss of records in fiscal year 1971, the following adjustments were made. Using the monthly reports of the total number of discharges from each Navajo Area hospital, the number of discharges on the IBM tape was compared with the number reported by the hospital. This comparison yields an estimate of the proportion reported on the tapes, which is between 85 and 95 percent for each hospital. It was assumed that the loss of records was random. The number of births likely to have occurred in each facility is adjusted on the basis of the proportion of records lost.

Data concerning pre-1970 deaths and births were obtained from volumes of Vital Statistics of the United States, but they do not provide information on tribal affiliation. Indeed, Indian births and deaths are reported together with those of Blacks, and are grouped simply as "non-Whites." As Blacks represent such a relatively small proportion of the population in the areas under consideration, this was not regarded as a major problem. Data from the vital statistics records rather than from the IHS were utilized because (1) many deaths may not occur in hospitals and thus would not appear in the IHS recordkeeping system, and (2) historical data on births and deaths are needed to calculate intrinsic rates of natural increase.

For denominator data two sources are used: BIA population data for the two tribes; and 1950, 1960, and 1970 census data for the five New Mexico and Arizona counties which include most of the Navajo and all of the Hopi Reservations. This is necessary because the IHS birth data can be applied most meaningfully to the BIA reservation population data, which include age and sex estimates for each tribe and for different parts of each reservation. The birth and death data from the volumes of vital statistics were available for counties, including off-reservation towns and villages, so a different denominator which included those areas was necessary--hence reliance on the U.S. Census.

The BIA data for the Navajo population are based on 1971 figures for enrolled tribal members resident in chapter areas on the reservation. The total at that time in this category was 130,000, which is thought to be accurate to plus or minus 10 percent (i.e., the population actually might vary from 117,000 to 143,000). In calculating crude and overall age-specific birth rates, both figures have been used in order to give some indication of the possible range. When comparing age-specific birth rates from different parts of the reservation, only the figures provided by the BIA have been used, rather than the upper and lower limits, simply for ease of presentation. The reader should be aware that the true figures could be higher or lower than those presented here. In general, however,

it is the BIA's opinion that these figures vary in the same direction. That is, it is unlikely that reported population figures are inflated by 10 percent in one subagency and deflated by 10 percent in another subagency. Another inadequacy of these data is the under-enumeration of children below the age of 5 years, which happens because children are not officially enrolled in the tribe until such time as they start school. Again, however, this under-enumeration is probably relatively constant from one part of the reservation to another.

The Hopi population data are based on a 1968 BIA survey of the reservation. These data are the most recent available, but do not represent a complete enumeration because some individuals refused to cooperate. Nonetheless, attempts were made to gather some data from informants concerning those families where first-hand information could not be obtained. For that reason, the age and sex figures for the reservation population are assumed to be reasonably accurate. In calculating rates, a growth rate of 2 percent per year has been assumed. The census figures have been adjusted upwards to apply to fiscal years 1971 and 1972.

The U.S. Census data as they apply to Indians in the five New Mexico and Arizona counties are also problematic. Observers of the census-taking procedure on-reservation estimate that the loss was about 25 percent in 1970. This was probably uniform across the reservation. In addition, tribal affiliation is not available from the U.S. Census. Thus, for birth and death rates prior to 1970, it is not possible to distinguish between Navajos and Hopis or between on- and off-reservation residents. The crude and infant death rates and crude birth rates reported here, therefore, apply county-wide, though as most Indians in each county live on-reservation, the rates may be considered to apply primarily to reservation residents.

Finally, in using the figures from the vital statistics volumes it must be kept in mind that the registration of births and deaths has been a particular problem when dealing with American Indians. It is very likely that there are errors due to under-reporting, but it may be assumed that the errors are essentially random from one county to another and that they are all in the same direction and of the same magnitude. (At the time of this writing, fertility and mortality data from this source were available only through 1968. In the calculations regarding migration it was necessary to assume that 1969 was essentially the same as 1968.)

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GLOSSARY

age-specific birth rate	the number of births per 1,000 women in specified age groups, usually given at 5-year intervals starting with age 15
BIA	Bureau of Indian Affairs
chi-square goodness-of-fit test	a statistical test which assesses the fit of the data to a hypothesized model; small values of the chi-square test statistic indicate a good fit of the data to the model
cohort analysis	a method of studying groups of individuals by following them longitudinally through time
contingency table	1. a table presenting a cross-classification of data in two or more ways; 2. where you place extra guests
crude birth rate	the number of births per 1,000 population
crude death rate	the number of deaths per 1,000 population
degrees of freedom (d-f)	index related to the number of cells in a contingency table
fertility ratio	the ratio of children under 5 years of age to each 1,000 women between ages 15 and 44
IHS	Indian Health Service
infant death rate	number of deaths of children (under the age of 1 year) per 1,000 live births
logit scale	a mathematical transformation of data classified into contingency tables which simplifies multiplicative models by transforming them to additive models
primigravida	a woman during her first pregnancy
p-value	a measure of whether the observed result of a statistical test of significance should be considered extreme; the probability of observing a value of the test statistic more extreme than the observed result, assuming the null hypothesis is true (small values of the p-value are considered extreme)
USPHS	United States Public Health Service

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